

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference HRW/ANR02A	FOR FURTHER ACTION <small>see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.</small>	
International application No. PCT/GB 00/ 02267	International filing date (day/month/year) 12/06/2000	(Earliest) Priority Date (day/month/year) 14/06/1999
Applicant ANRITSU LIMITED		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.
☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing:
- ☐ contained in the international application in computer readable form.
- ☐ filed together with the international application in written form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. ☐ **Certain claims were found unsearchable** (See Box I).
3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the title,

- ☐ the text is approved as submitted by the applicant.
- ☒ the text has been established by this Authority to read as follows:
APPARATUS FOR TESTING MOBILE PHONES

5. With regard to the abstract,

- ☒ the text is approved as submitted by the applicant.
- ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

- ☐ as suggested by the applicant.
- ☒ because the applicant failed to suggest a figure.
- ☐ because this figure better characterizes the invention.

2
☐ None of the figures

INTERNATIONAL SEARCH REPORT

International Application No

GB 00/02267

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KALL J: "THE GSM SYSTEM SIMULATOR" PROCEEDINGS OF THE EUROPEAN CONFERENCE ON ELECTROTECHNICS. (EUROCON), US, NEW YORK, IEEE, vol. CONF. 8, 1988, pages 478-481, XP000010527 page 478, column 1, paragraph 1 -page 479, column 2, paragraph 1 page 480; figures 1-3 -----	1-17
A	US 4 669 091 A (NOSSEN EDWARD J) 26 May 1987 (1987-05-26) abstract column 7, line 16-65 figure 5 -----	15-17

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

13 September 2000

Date of mailing of the international search report

21/09/2000

Name and mailing address of the ISA

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

GB 00/02267

Patent document
cited in search report

Publication
date

Patent family
member(s)

Publication
date

US 4669091

A

26-05-1987

NONE

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

WOODCRAFT, D.C.
BROOKES BATCHELLOR
102-108 Clerkenwell Road
London EC1M 5SA
GRANDE BRETAGNE

RECEIVED

21 SEP 2001

B.B.

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NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing
(day/month/year)

19.09.2001

Applicant's or agent's file reference
HRW/sb/ANR02A

IMPORTANT NOTIFICATION

International application No.
PCT/GB00/02267

International filing date (day/month/year)
12/06/2000

Priority date (day/month/year)
14/06/1999

Applicant

ANRITSU LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301). 21.12.01

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



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Form PCT/IPEA/416 (July 1992)

INTERNATIONAL SEARCH REPORT


Information on patent family members

International Application No

PCT/GB 00/02267

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4669091	A	26-05-1987	NONE

Form PCT/ISA/210 (patent family annex) (July 1992)

04/01/2001	Date of completion of this report	19.09.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer	Lauri, L
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Form PCT/IPEA/409 (cover sheet) (January 1994)



**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/02267

I. Basis of the report

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):
- Description, pages:

1-3,5-11 as originally filed

4,4a as received on 06/06/2001, with letter of 01/06/2001

Claims, No.:

1-17 as originally filed

Drawings, sheets:

1/3-3/3 as originally filed

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/02267

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims 1-17 No: Claims
Inventive step (IS)	Yes: Claims 1-17 No: Claims
Industrial applicability (IA)	Yes: Claims 1-17 No: Claims

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

CITED DOCUMENTS

D1: KALL J: 'THE GSM SYSTEM SIMULATOR' PROCEEDINGS OF THE EUROPEAN CONFERENCE ON ELECTROTECHNICS. (EUROCON), US, NEW YORK, IEEE, vol. CONF. 8, 1988, pages 478-481, XP000010527

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The document D1 is regarded as the closest prior art to the subject-matter of claim 1, and shows an apparatus for testing radio apparatus (mobile phones) with the following features:
 - an RF signal generator (TX 1) for transmitting an RF signal to said radio apparatus (mobile phone);
 - an RF receiver (RX 1) for receiving an RF signal (RF11) from said radio apparatus (mobile phone);
 - a digital signal generator (speech codec) for generating and outputting a digital signal

However D1 does not describe nor does it suggest the following features comprised in claim 1:

- signal modifying means (111,112) connected to receive said digital signal (DSIG3) from said digital signal generator (102) and to receive said digital signal (DSIG14, DSIG15) from said RF receiver (129) whereby to modify said digital signal (DSIG3) from said digital signal generator (102) in accordance with said digital signal (DSIG14, DSIG15) from said RF receiver to thereby output a first modified digital signal (DSIG11, DSIG12) to provide the basis of said digital signal (DSIG10) input to said RF signal generator (122).

Therefore claim 1 is considered to fulfil the requirements of Article 33(2) and 33(3) PCT, because the subject-matter of claim 1 is new over the prior art (Rule 64 PCT).

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference HRW/sb/ANR02A	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB00/02267	International filing date (day/month/year) 12/06/2000	Priority date (day/month/year) 14/06/1999
International Patent Classification (IPC) or national classification and IPC H04B17/00		
Applicant ANRITSU LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 5 sheets, including this cover sheet.

- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 04/01/2001	Date of completion of this report 19.09.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Lauri, L Telephone No. +49 89 2399 7304 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB00/02267

2. Claim 15 is also considered to fulfil the requirements of Article 33(2) and 33(3) PCT, because it contains the following features that are not described in D1:
- analog signal generator (122) for receiving an input digital signal (DSIG10) and providing an output analog signal (RF10) having characteristics determined by the input digital signal (DSIG10) input thereto;
 - means (112,116) for providing said input digital signal comprising means for receiving a digital signal (DSIG4, DSIG5).
- These features are neither described nor suggested by D1.

Re Item VII

Certain defects in the international application

Claim 14 comprises all the features of claim 1 and should therefore be formulated as a claim dependent on the latter (Rule 6.4 PCT).

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the two RF signals being summed to be passed to the mobile phone 14, and the signal RF6 replicating the return signal to the antennae. There are a number of problems associated with this arrangement and these generally relate to the summer 11, to the various coaxial cables and the extractor 13. The coaxial cable is important. The length of the coaxial cable is particularly important because there is a phase change along the length of the coaxial cable. Thus, in terms of the length of cable between S1, S2 and the summer 11 there may be an unintentional phase change, and the summer can introduce a phase change. The coaxial cable can also introduce reflections into the system. It is also difficult to accurately maintain and generate the same power outputs via two fading simulators. In practice it is necessary to measure the signal passing along the coaxial cable 11 to adjust the various components including the base station simulators S1, S2 and the fading simulators FS1, FS2 so as to provide a signal of a known desired type to the mobile phone 14.

There are similar problems in dealing with the signal RF6.

The present invention relates to a method and apparatus arranged so as to reduce or remove the above problems.

Reference may also be made to Kall J: 'the GSM system simulator' proceedings of the European conference on Electrotechnics. (Eurocon), US, New York, IEEE, vol. Conf. 8, 1988, pages 478-481, which discloses GSM system simulator comprising a collection of emulation and measurement tools to be used when testing mobile stations for conformance with the CEPT/GSM recommendations.

Reference may also be made to the US Patent Specification, 4 669 091 which discloses a communication system which transmits information which may be in the form of frames or bursts of suppressed-carrier data over a dispersive transmission path which introduces multipath distortion. Each frame is stored as it is received and processed by iteratively simulating the multipath distortion, subtracting the distortion from the stored frame to form a corrected signal, and evaluating the quality of the resulting

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signal. The quality of the resulting signal is determined by frequency multiplying the corrected signal and evaluating the total power of components other than the frequency multiplied carriers. The iterative procedure adjusts the phase and, if desired, the amplitude of signals tapped from a delay line.

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The present invention provides an apparatus for testing a radio apparatus of a type which receives a radio frequency (RF) signal from a RF signal generator and sends a RF signal to a receiver to modify the characteristics of the RF signal transmitted by said signal generator, said apparatus comprising:

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an RF signal generator for transmitting an RF signal (RF10) to said radio apparatus, and means to receive an input digital signal (DSIG10), which signal generator controls the characteristics of the RF signal (RF10) transmitted in accordance with the input digital signal (DSIG10);

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an RF receiver for receiving an RF signal (RF11) from said radio apparatus, said RF receiver including means to generate an output digital signal (DSIG14, DSIG15) having characteristics dependent on the characteristics of the RF signal (RF11) received;

AMENDED SHEET

(19) World Intellectual Property Organization
International Bureau



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21 December 2000 (21.12.2000)

PCT

(10) International Publication Number
WO 00/78063 A2

(15) International Patent Classification⁷: **H04Q 7/00**

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(25) Filing Language: **English**

(26) Publication Language: **English**

(30) Priority Data:
9913843.0 **14 June 1999 (14.06.1999)** **GB**

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(72) Inventor; and

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(74) Agent: **BROOKES & MARTIN**; High Holborn House, 52-54 High Holborn, London WC1V 6SE (GB).

(81) Designated States (*national*): AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— *Without international search report and to be republished upon receipt of that report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.



WO 00/78063 A2

(54) Title: **TESTING MOBILE PHONES**

(57) Abstract: An apparatus for testing a cellular phone comprising an RF signal generator (122) for transmitting an RF signal (RF10) to said cellular phone, said RF signal generator receiving an input digital signal (DSIG10) which determines the characteristics of the RF signal, means (112, 116) for providing said input digital signal comprising means for receiving a digital signal (DSIG4, DSIG5), and at least one set of digital means, each set (A, B, C) of digital means comprising: a first digital means (200, 201, 202) to provide a first digital signal element relating to a first characteristic of said RF signal, and a second digital means (MA, MB, MC) to provide a second digital signal element relating to a second characteristic of said RF signal, and a means (203) to combine said digital signal elements to provide said input signal to said RF signal generator, said first, second and third characteristics comprise phase, amplitude and delay respectively. Thus the signal processing is carried out in the digital phase which is more easily controlled.

TESTING MOBILE PHONES

The present invention relates to the testing of cellular mobile phones and in particular a method for testing third generation (3G) cellular mobile phones. 3G cellular radio systems will employ a new technique called Tx diversity in order to improve reception and increase the overall efficiency of the network. Two or more signal generator antennae will be used at each base station.

It is well known that mobile phone communications are provided by transmission of signals in both directions between an antenna at a base station and a mobile phone. Conditions may vary in the path between the base station and the mobile phone and this can create problems, such as fading. In first generation (analog) mobile telephony, the rate of information fed along the channel from the base station to the mobile phone (and vice versa) is relatively slow and the delay spread caused by changes in the environment between the base station and the mobile phone is less than one data symbol. For example, the delay spread is usually 15 microseconds or less. Thus, a mobile phone receiver does not notice this.

However, in more recent (second generation) mobile telephony, for example GSM, the transmission rate is much faster and so it is possible for the delay spread to be of the same order of magnitude as the information rate. (Eg one piece of information every 3.6 microsecond.) As a result, the signal when received by the GSM mobile phone may include echoes. There may be many echoes because the signal may be received by the mobile phone via a variety of different paths with different environmental effects.

The mobile phone will normally deal with this by tuning to each echo and combining all or several echoes to determine the transmitted information. The echoes may exhibit time diversity, that is echoes of the same data signal may arrive at different times (out of phase) and as a result, depending on the phase relationship of the echoes, the echoes may add or subtract which can create fading or increase of the signal. If the two echoes cancel each other out then the mobile phone, which provides an indication back

to the base station of the signal strength which is it receiving, will effectively instruct the base station to increase the power output and this is undesirable for a number of reasons.

5 It has been proposed to overcome or reduce these problems in the 3G wireless telephony base stations by providing at some or all of the base stations two (or more) antennae usually separated by fractions or multiples of the wavelength of the signal, for example, half, one, two wavelengths and transmitting antenna specific signals such that a mobile phone can distinguish them and then feed back signals to separately
10 correct the relevant antenna output.

The RF receiver in the 3G mobile telephone includes a system which can separate out a relevant part of the signals from the two antennae. The mobile phone measures the power and phase of the signal received from the first antenna and the power and phase
15 of the signal received from the second antenna and transmits a signal back to the base station to cause the base station to adjust the phase and power between the two antennae so as to improve the reception at the mobile phone. In practice, each antenna transmits a signal which comprise two components, firstly a component which relates to the common information (ie traffic and typically relates to the information being
20 transmitted to the mobile phone), and a second antenna specific signal (a pilot signal) which enables the mobile phone to distinguish which antenna is which.

The mobile phone uses the pilot signal to measure the phase and power received from each antenna and to thereby provide the information returned to the base station to
25 adjust the output of the antennae.. Thus the mobile phone returns to the base station a complex vector signal which sets out the relationship between the pilot signals from each antenna and generally will try to get the same power and same phase from each antenna. In a typical system, the mobile phone will send sixteen hundred correction signals per second back to the base station so that as the relative strengths and phases
30 of the signals from each antenna vary in real time, the signals on the two antennae may be corrected so as to counter the effect of fading.

For a particular design of mobile phone to be approved for use with the system, it is necessary to be able to test that mobile phone to see whether or not it will be able to identify the signals from each antenna and sufficiently accurately measure the power and phase of the signals so as to be able to operate the system properly.

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The present application relates to a method and apparatus for testing mobile phones, particularly 3G mobile phones in this way. Of course it is possible to test each individual mobile phone separately, but in practice the present arrangement is intended to be used for each particular design of mobile phone during its development so as to ensure that the design complies with the necessary standard. Such apparatus is also useful in conformance testing, research and development, as well as production.

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It is preferred that the apparatus and method may simulate conditions found in real life, so that the signals between the two antennae may be set at particular static levels, and may also be dynamically varied.

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A traditional approach which might be applied to testing 3G mobile phones is diagrammatically set out in Figure 1. There is provided two (or more) base station simulators (S1, S2) which each provide a relevant RF (radio frequency) signal output, RF1, RF2, each RF output signal being passed through a respective fading simulator, FS1, FS2, and thereby providing a respective new RF signal, RF3, RF4. These two RF signals are combined in a summer 11 and the combined RF signal RF5 is passed by a coaxial line 12A, 12B via an extractor 13 to the antenna input 15 of a mobile phone 14 under test. The antenna of the mobile phone 14 transmits a signal RF6 (at a different frequency to RF5) which passes to the extractor 13 where it is separated from RF5 and passed to a signal processor 16 which provides two non-RF signal outputs SIG7, SIG8, dependent upon the power and phase of RF3, RF4 respectively. These signals, SIG7, SIG8, are passed to the base station simulators, S1, S2.

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Such an arrangement, of course, replicates the system in the field, the two base signal simulators providing RF signals replicating those produced by the two antennae. and

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the two RF signals being summed to be passed to the mobile phone 14, and the signal RF6 replicating the return signal to the antennae. There are a number of problems associated with this arrangement and these generally relate to the summer 11, to the various coaxial cables and the extractor 13. The coaxial cable is important. The length of the coaxial cable is particularly important because there is a phase change along the length of the coaxial cable. Thus, in terms of the length of cable between S1, S2 and the summer 11 there may be an unintentional phase change, and the summer can introduce a phase change. The coaxial cable can also introduce reflections into the system. It is also difficult to accurately maintain and generate the same power outputs via two fading simulators. In practice it is necessary to measure the signal passing along the coaxial cable 11 to adjust the various components including the base station simulators S1, S2 and the fading simulators FS1, FS2 so as to provide a signal of a known desired type to the mobile phone 14.

There are similar problems in dealing with the signal RF6.

The present invention relates to a method and apparatus arranged so as to reduce or remove the above problems.

The present invention provides an apparatus for testing a radio apparatus of a type which receives a radio frequency (RF) signal from a RF signal generator and sends a RF signal to a receiver to modify the characteristics of the RF signal transmitted by said signal generator, said apparatus comprising:

an RF signal generator for transmitting an RF signal (RF10) to said radio apparatus, and means to receive an input digital signal (DSIG10), which signal generator controls the characteristics of the RF signal (RF10) transmitted in accordance with the input digital signal (DSIG10);

an RF receiver for receiving an RF signal (RF11) from said radio apparatus, said RF receiver including means to generate an output digital signal (DSIG14, DSIG15) having characteristics dependent on the characteristics of the RF signal (RF11) received;

a digital signal generator for generating and outputting a digital signal (DSIG3);

signal modifying means connected to receive said digital signal (DSIG3) from said digital signal generator and to receive said digital signal (DSIG14, DSIG15) from said RF receiver whereby to modify said digital signal (DSIG3) from said digital signal generator in accordance with said digital signal (DSIG14, DSIG15) from said RF receiver to thereby output a first modified digital signal (DSIG11, DSIG12) to provide the basis of said digital signal (DSIG10) input to said RF signal generator.

The present invention may also provide an apparatus for testing a cellular phone comprising

an RF signal generator for transmitting an RF signal (RF10) to said cellular phone;

an RF receiver for receiving an RF signal (RF11) from said cellular phone, said RF receiver generating first and second digital signals (DSIG14, DSIG15) relating to different characteristics of the received RF signal (RF11);

a digital signal generator for generating a digital signal (DSIG3), which digital signal is passed to a first and a second channel;

a first antenna specific digital signal generator;

a second antenna specific digital signal generator;

whereby the digital signal (DSIG3) from the first digital signal generator in the first channel is modified by the first of the digital signals (DSIG14) from the RF receiver and in the second channel is modified by the second of the digital signals (DSIG15) from the RF receiver, the modified digital signal (DSIG12) in said first channel being further modified by a digital signal (DSIG2) provided by the first antenna specific digital signal generator, and the modified digital signal (DSIG11) in the second channel being further modified by a digital signal (DSIG1) from the second antenna specific digital signal generator;

a first fading simulator being provided in the first channel to modify the further modified digital signal (DSIG5) passing along said channel in such a manner as to replicate a preferred pattern of variation;

a second fading simulator being provided in the second channel to modify the further modified digital signal (DSIG14) passing along said channel in such a manner as to replicate a preferred pattern of variation;

the digital signals (DSIG7,DSIG5) from the first and second fading simulators being combined to provide an input signal (DSIG8,DSIG10) to the RF signal generator;

whereby as the fading simulators modify the relevant digital signals to thereby modify the RF signal (RF10) provided by the RF signal generator, the cellular telephone provides a feed back signal (RF11) which modifies the digital signals in the two channels so as to compensate for the effect of the fading simulators in a measurable manner.

The present invention may also provide an apparatus for providing an analog signal having predetermined characteristics comprising:

analog signal generator for receiving an input digital signal (DSIG10) and providing an output analog signal (RF10) having characteristics determined by the input digital signal (DSIG10) input thereto:

means for providing said input digital signal comprising means for receiving a digital signal (DSIG4, DSIG5), and at least one set of digital means, each set (A, B, C) of digital means comprising:

a first digital means to provide a first digital signal element relating to a first characteristic of said analog signal, and

a second digital means (MA, MB, MC) to provide a second digital signal element relating to a second characteristic of said analog signal, and

a means to combine said digital signal elements to provide said input signal to said analog signal generator.

A preferred embodiment will now be described by way of example only and with reference to the accompanying drawings in which:-

Figure 2 sets out the apparatus of the invention diagrammatically, and,

Figure 3 shows in diagrammatic form the arrangement of each fade simulator.

Referring to Figure 2 there are shown three baseband (ie non-RF) digital signal generators, 100, 102, 103, signal generator 100 producing an antenna specific coding signal DSIG1 which, relates to the pilot signal of a first antenna. The output signal DSIG1 which is digital is passed along line 104 to a multiplier 105. The baseband digital signal generator 103 produces an antenna specific coded signal DSIG2 similar to that produced by 100 but relating to the pilot signal of the second antenna. The output digital signal DSIG2 is passed via line 106 to a multiplier 107.

Baseband digital signal generator 102 is arranged to provide, in digital form, the common channel signal DSIG3 (corresponding, for example, to the traffic signal carrying, for example, the telephone message) and is passed via line 108 and multipliers 111, 112, respectively to multipliers 105, 107. The digital output signal DSIG4 of the multiplier 105 is passed via line 113 to a fading simulator 116 to be described in more detail with reference to Figure 3 later and the digital output signal DSIG5 of multiplier 107 is similarly passed along line 114 to a fading simulator 112 to be described in more detail with reference to Figure 3 later. The output signal DSIG6 of fading simulator 116 is passed via line 118 to a summer 119 and similarly the output signal DSIG7 of the fading simulator 112 is passed via line 117 to the other input of the summer 119. The output signal DSIG8 of the summer 119 is passed via summer 121 to a radio frequency signal generator 122. The summer 121 is also connected via switch 123 to a noise generator, in particular, an Additive Gaussian White Noise generator 124 (which simulates traffic on the network). It will be noted that the signal input to the generator 122 is a digital baseband signal.

The components 103, 112, 107, 112, provide a first channel A and the components 100, 111, 105, 116, provide a second channel B.

The RF output signal RF10 from the signal generator 122 is provided to an RF line 126 in the form of coaxial cable connected to an antenna input of a mobile phone 127

under test via a separator 125.

The radio frequency output signal RF11 from the antenna port of the mobile phone 127 when separated by separator 125 is passed by a coaxial line 128 to a processing apparatus 129.

The processing apparatus 129 processes the signal received and provides two output signals W1 and W2 on lines 131, 132 respectively, which are passed to the other inputs of the multipliers 112, 111 respectively.

The apparatus of Figure 2 operates as follows.

A mobile phone 127 to be tested is connected to the apparatus as shown in Figure 2. The mobile phone may be a phone in the design or development phase whereby the apparatus may be used to test the efficiency of operation of the design, or alternatively, may be used to test production mobile phones.

The antenna or an antenna port of the mobile phone is connected to the coaxial line 130 by a suitable connector.

In use, the two baseband digital signal generators 100, 103 provide a respective digital baseband signal, each of which is multiplied with the common channel signal provided by the signal generator 102 at the respective multipliers 105, 107. Fading simulators 116, 117 are operated in accordance with a prearranged schedule (to be described later) and the two signals from the respective fading simulators are combined at summer 119, are furthermore combined with the white signal noise at summer 121 and the combined digital signal is used to control the RF signal generator 122 which thereby provides a signal RF10 based on the combined data signal.

In a first test procedure, the outputs of the various signal generators 100, 102, 103, and the operation of the fading simulators 116, 117, are set to preset static conditions

so as to produce at 118, 117, digital signals which relate to RF signals which are of a known power level and phases which are of a known offset.

The mobile phone 127 is then tested and the relevant values determined by the phone 127 are compared with the known offset and known signal level and these must agree to within specified limits.

Before describing a second operation of the apparatus in which the fading simulators 116, 117 are operated in accordance with a prearranged schedule, which will be described later, it is convenient at this point to describe the operation of the fading simulators used in a preferred embodiment of the invention.

We will now describe the fading simulators 117, 116 with reference to Figure 3. The fading simulators are devices which take an input signal DSIG4 or DSIG5 and produce an output DSIG6 or DSIG7 respectively in which:-

- (a) the phase of the output signal is selectively varied with respect to the phase of the input signal, and the amplitude of the output signal is selectively varied with respect to the amplitude of the input signal, and/or
- (b) the output signal DSIG6 or DSIG7 includes plural components which correspond to echoes, each of the plural components having a variable amplitude and variable phase with respect to the input and with respect to each other.

In essence, the input signal (DSIG14, DSIG15) to the fading simulator is passed to a plurality of parallel channels A, B, C each of which includes a respective variable delay apparatus (200, 201, 202). The delay to the signal created by the delay apparatus may either be statically arranged or the delay apparatuses may be controlled by a respective control signal (SA, SB, SC respectively) applied to each delay apparatus to vary the delay in a known or random manner.

The outputs of each delay are passed to a respective multiplier (MA, MB, MC). Each

multiplier has an input to which a complex control signal (PA, PB, PC) is provided, the complex signal either being preset or varied in a known or random manner. The outputs of the multipliers are combined in summer (203) to provide a single signal output (DSIG6, DSIG5) which carries a signal which has a number of components corresponding to the number of delays which thereby have independent variable amplitudes and independent variable phase shifts, and it will be understood that the amplitude and phase shifts may be static or may be changed in accordance with a known pattern, or may be changed in a random manner. Each of these signal components produced by the channels A, B, C respectively will effectively correspond to a separate echo in the RF signal (RF10) and will be handled by the mobile phone as if they were echos produced in the field.

Thus in the second operation of the apparatus, in distinction to the first operation of the apparatus in which the signal DSIG6 or DSIG7 has a number of components with a fixed relationship with respect to amplitude and phase to the input signal DSIG4 or DSIG5, the phase and amplitude of the components of the signal DSIG6 and DSIG7 will vary with time either in a random manner or in a predetermined manner. (It is useful to use a predetermined pattern of variation because this enables one then to compare different mobile phones with exactly the same signal.)

The way in which the efficiency and operation of the mobile phone is tested in this case is to arrange for the signal generator 102 to provide a prearranged digital pattern, and for the mobile phone to report the error bit rate. The error bit rate must be within predetermined limits and also it may be shown by switching off the feed back arrangements (for example by breaking the link 128) that the mobile phone when utilising the system calling the invention provides an improved error bit rate than without using the system of the invention.

It will be understood that the present invention provides an improved apparatus for testing mobile phones in this environment.

In the described arrangement, there is only a single RF signal generator 122 and the simulation of the two antennae takes place in the baseband digital domain between the signal generators 100, 102, 103 and fading simulators 116, 117. Since the signals are digital at this point, the relative level and phase can be very accurately controlled.

5

Since it is mainly the relative values that are important (for each antenna) and since they are all in the digital domain, the system is intrinsically accurate. Absolute levels are more easily controlled and only one RF generator is required.

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The invention is not restricted to the details of the foregoing example.

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The Additive Gaussian White Noise generator 124 provides a noise source which in the example shown in Figure 2 is summed in the digital domain but can if necessary be applied to the RF signal output from the RF signal generator 122. By the arrangement provided, only a single such noise source is required.

CLAIMS

1. An apparatus for testing a radio apparatus of a type which receives a radio frequency (RF) signal from a RF signal generator and sends a RF signal to a receiver to
5 modify the characteristics of the RF signal transmitted by said signal generator, said apparatus comprising:

an RF signal generator (122) for transmitting an RF signal (RF10) to said radio apparatus (127), and means to receive an input digital signal (DSIG10), which signal generator (122) controls the characteristics of the RF signal (RF10) transmitted in
10 accordance with the input digital signal (DSIG10);

an RF receiver (129) for receiving an RF signal (RF11) from said radio apparatus (127), said RF receiver (129) including means to generate an output digital signal (DSIG14, DSIG15) having characteristics dependent on the characteristics of the RF signal (RF11) received;

15 a digital signal generator (102) for generating and outputting a digital signal (DSIG3);

signal modifying means (111, 112) connected to receive said digital signal (DSIG3) from said digital signal generator (102) and to receive said digital signal (DSIG14, DSIG15) from said RF receiver (129) whereby to modify said digital signal (DSIG3) from said digital signal generator (102) in accordance with said digital signal (DSIG14, DSIG15) from said RF receiver to thereby output a first modified digital
20 signal (DSIG11, DSIG12) to provide the basis of said digital signal (DSIG10) input to said RF signal generator (122).

25 2. Apparatus as claimed in claim 1 in which said radio apparatus comprises a cellular phone.

3. Apparatus as claimed in claim 1 or claim 2 in which there is provided a second digital signal generator (100, 103 for generating and outputting a digital signal (DSIG1, DSIG2), second signal modifying means (105, 107) being connected to
30 receive the digital signal (DSIG, DSIG2) from said second digital signal generator

(100, 103) and connected to receive said first modified digital signal (DSIG11, DSIG12) from said first signal modifying means (111, 112) whereby to modify said first modified digital signal (DSIG11, DSIG12) in accordance with said digital signal (DSIG1, DSIG2) from said second digital signal generator (100, 103) to thereby
5 output a second modified digital signal (DSIG4, DSIG5) to provide the basis of said digital signal (DSG10) input to said RF signal generator (122).

4. Apparatus as claimed in claim 3 including a digital fading simulator (112, 116), connected to receive said second modified digital signal, the output (DSIG6, DSIG7)
10 of the digital fading simulator comprising the second modified digital signal (DSIG4, DSIG5) the characteristics of which have been modified.

5. Apparatus as claimed in claim 4 in which said digital fading simulator includes means to change at least one of said digital signal elements of said second modified
15 digital signal (DSIG4, DSIG5) to thereby change the phase or amplitude or delay of the RF signal (RF10) transmitted by said RF signal generator (122).

6. Apparatus as claimed in claims 5 in which the fading simulator includes means to vary one or more of said digital signal elements in accordance with a predetermined
20 pattern with respect to time.

7. Apparatus as claimed in any of claims 1 to 6 in which the or each digital signal generator outputs a digital signal including digital signal elements relating to one or more of phase, amplitude, and delay in respect of the resultant RF signal (RF10)
25 transmitted by the RF signal generator (122).

8. Apparatus as claimed in claim 1 or 2 in which said RF receiver (129) includes means to generate two output digital signals (DSIG14, DSIG15) having characteristics based on different characteristics of the RF signal (RFII) received by the receiver
30 (129), and there are provided a second and third digital signal generators (100, 103) which output respective digital signals (DSIG1, DSIG2), said signal modifying means

(111, 112) comprising first and second signal modifying means (111, 112) connected to respectively receive a digital signal (DSIG3) from said first digital signal generator (102) and to receive a respective digital signal (DSIG14, DSIG15) from said RF receiver (129) whereby to modify said digital signal (DSIG3) from said first digital signal generator (102) in accordance with said digital signal (DSIG14, DSIG15) from said RF receiver to thereby output a respective first and second modified signal (DSIG11, DSIG12), third and fourth signal modifying means (105, 107) connected to receive a digital signal (DSIG1, DSIG2) from a respective one of the second or third digital signal generators (100, 103) and connected to receive said digital signal (DSIG11, DSIG12) from a respective one of said first or second signal modifying means 111, 112 whereby to modify the respective modified digital signal (DSIG11, DSIG12) in accordance with said digital signal (DSIG1, DSIG2) from the relevant second or third digital signal generator (100, 103) and to thereby output third and fourth modified digital signals (DSIG4, DSIG5), a combination of digital signals derived from said third and fourth modified signals (DSIG4, DSIG5) providing said digital signal input to said RF signal generator (122).

9. Apparatus as claimed in claim 8 including:

a first digital fading simulator (116), connected to receive said third modified digital signal (DSIG4), the output (DSIG6) of the first digital fading simulator (116) comprising a fifth modified digital signal (DSIG6) the characteristics of which have been modified by said first digital fading simulator;

a second digital fading simulator (112), connected to receive said fourth modified digital signal (DSIG5), the output (DSIG6) of the second digital fading simulator (116) comprising a sixth modified digital signal (DSIG7) the characteristics of which have been modified by said second digital fading simulator; and

a digital signal combines means (119) to combine said fifth and sixth digital signal to provide a seventh digital signal (DSIG8).

10. Apparatus as claimed in claim 9 in which each digital fading simulator (116, 112) includes means to change at least one of said digital signal elements of said third

or fourth modified digital signal (DSIG4, DSIG5) to thereby change the phase or amplitude or delay of the RF signal (RF10) transmitted by said RF signal generator (122).

5 11. Apparatus as claimed in claims 10 in which each digital fading simulator (116, 112) includes means to vary one or more of said digital signal elements in accordance with a predetermined pattern with respect to time.

10 12. Apparatus as claimed in any of claims 1 to 11 in which it is provided a white noise digital signal generator (124), the digital output signal DSIG9 of said white noise digital signal generator being applied to the digital signal applied to digital signal DSIG10 input to said RF signal generator (122).

15 13. Apparatus as claimed in claim 2 and 8 in which said first digital signal generator (102) provides a digital signal (DSIG3) corresponding to a common channel RF signal when applied to the RF signal generator (122), and said second and third digital signal generators (100, 103) provide output digital signals DSIG1 and DSIG2 which correspond to antenna specific RF signals when applied to said RF signal generator (122).

20 14. An apparatus for testing a cellular phone comprising
an RF signal generator (122) for transmitting an RF signal (RF10) to said cellular phone;
an RF receiver (129) for receiving an RF signal RF11) from said cellular phone
25 (127), said RF receiver (129) generating first and second digital signals (DSIG14, DSIG15) relating to different characteristics of the received RF signal (RF11);

30 a digital signal generator (102) for generating a digital signal (DSIG3), which digital signal is passed to a first and a second channel;
a first antenna specific digital signal generator (103);
a second antenna specific digital signal generator (100);

whereby the digital signal (DSIG3) from the first digital signal generator in the first channel is modified by the first of the digital signals (DSIG14) from the RF receiver (129) and in the second channel is modified by the second of the digital signals (DSIG15) from the RF receiver (129), the modified digital signal (DSIG12) in said first channel being further modified by a digital signal (DSIG2) provided by the first antenna specific digital signal generator (103), and the modified digital signal (DSIG11) in the second channel being further modified by a digital signal (DSIG1) from the second antenna specific digital signal generator (100);

a first fading simulator (112) being provided in the first channel to modify the further modified digital signal (DSIG5) passing along said channel in such a manner as to replicate a preferred pattern of variation;

a second fading simulator (116) being provided in the second channel to modify the further modified digital signal (DSIG14) passing along said channel in such a manner as to replicate a preferred pattern of variation;

the digital signals (DSIG7, DSIG5) from the first and second fading simulators being combined to provide an input signal (DSIG8, DSIG10) to the RF signal generator (122);

whereby as the fading simulators modify the relevant digital signals to thereby modify the RF signal (RF10) provided by the RF signal generator (122), the cellular telephone provides a feed back signal (RF11) which modifies the digital signals in the two channels so as to compensate for the effect of the fading simulators in a measurable manner.

15. Apparatus for providing an analog signal having predetermined characteristics comprising:

analog signal generator (122) for receiving an input digital signal (DSIG10) and providing an output analog signal (RF10) having characteristics determined by the input digital signal (DSIG10) input thereto:

means (112, 116) for providing said input digital signal comprising means for receiving a digital signal (DSIG4, DSIG5), and at least one set of digital means, each set (A, B, C) of digital means comprising:

a first digital means (200, 201, 202) to provide a first digital signal element relating to a first characteristic of said analog signal, and

a second digital means (MA, MB, MC) to provide a second digital signal element relating to a second characteristic of said analog signal, and

5 a means (203) to combine said digital signal elements to provide said input signal to said analog signal generator.

16. Apparatus as claimed in claim 15 in which each of said set of digital means includes a third digital means to provide a third digital signal element relating to a third
10 characteristic.

17. Apparatus as claimed in claim 16 in which said first, second and third characteristics comprise phase, amplitude and delay respectively.

1/3

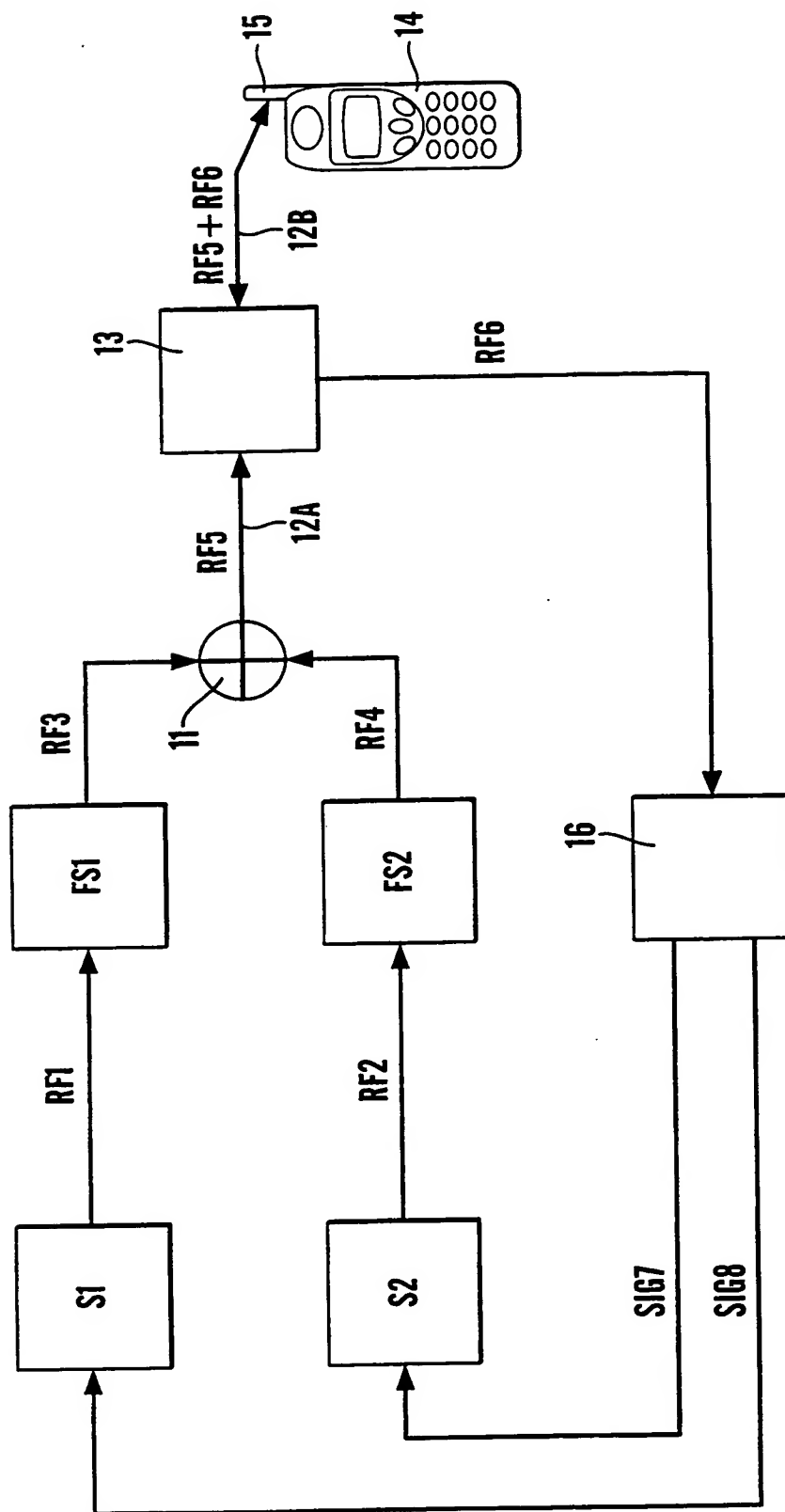


Fig. 1

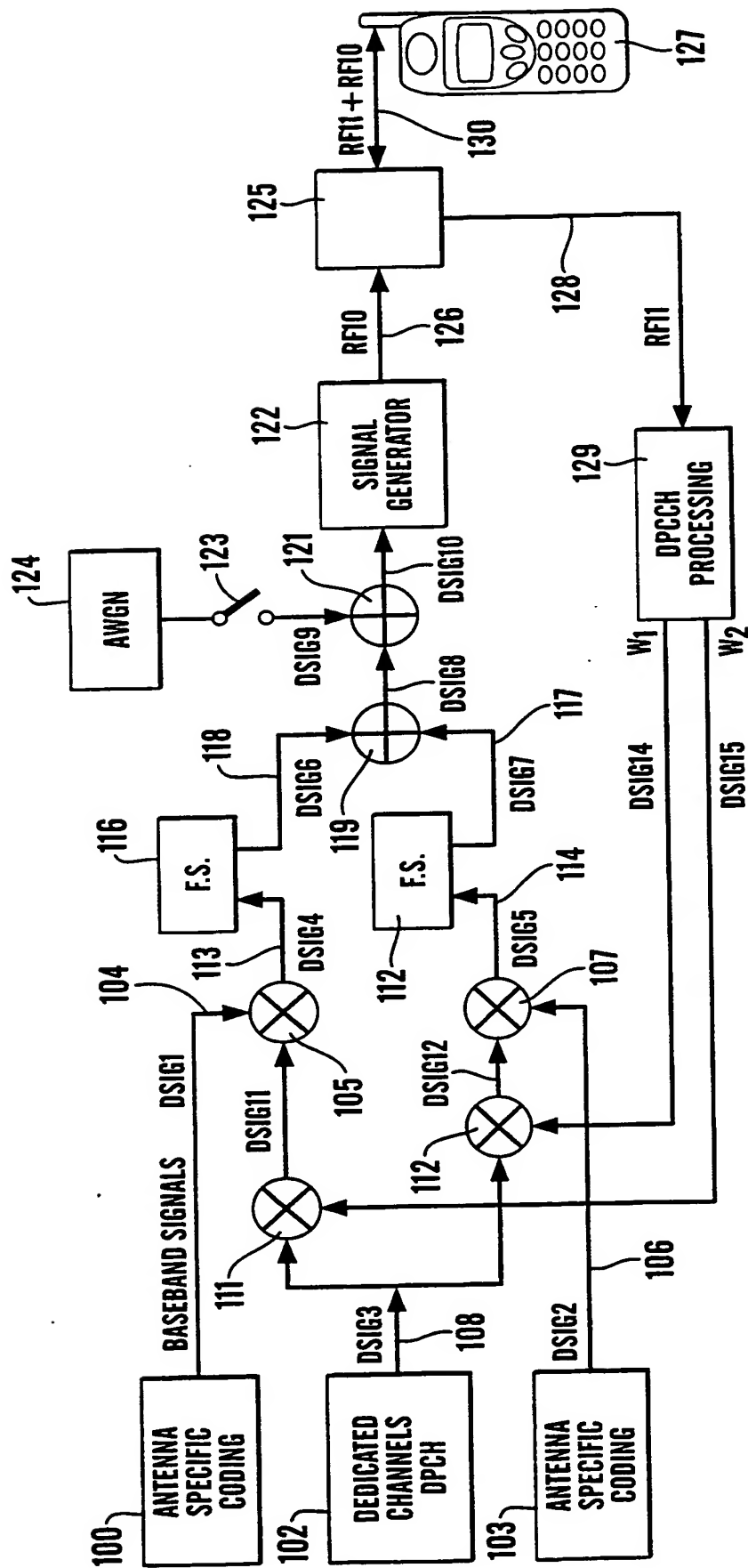
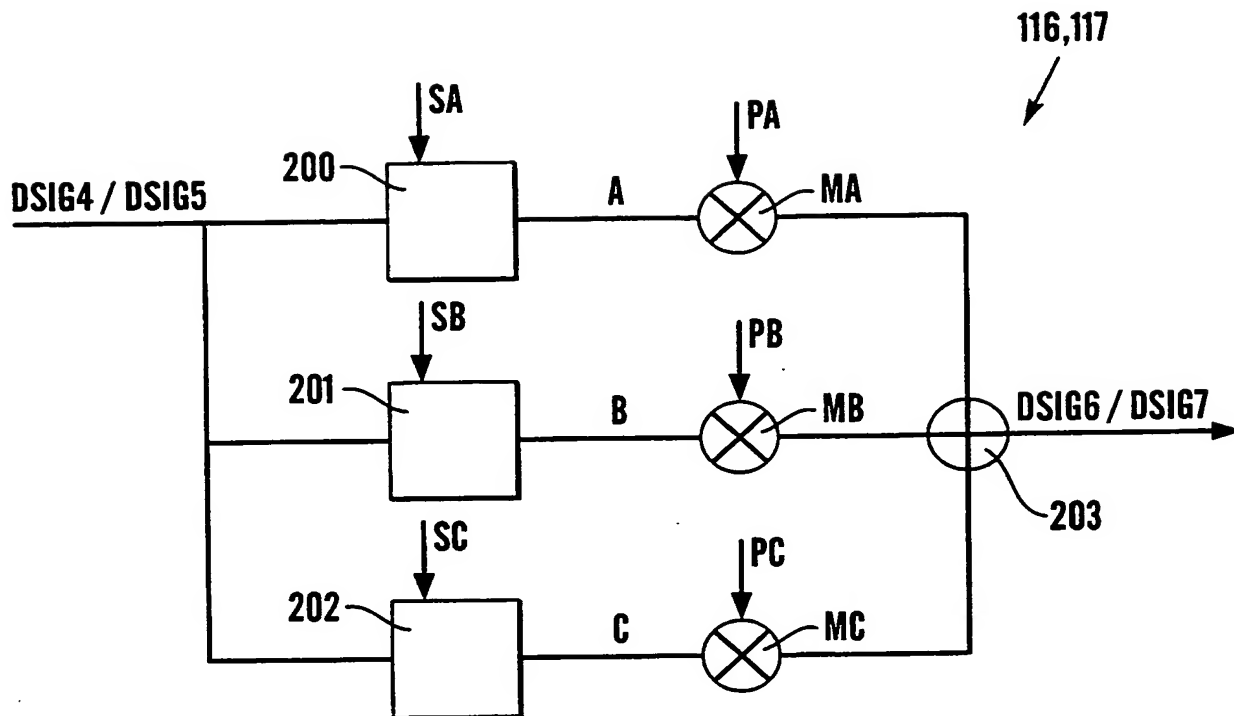


Fig. 2

*Fig.3*

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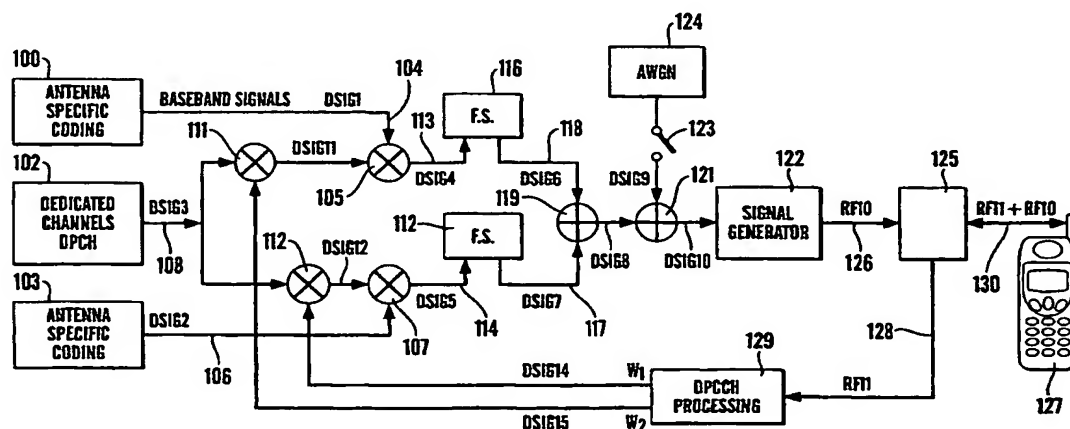
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **APPARATUS FOR TESTING MOBILE PHONES**



(57) Abstract: An apparatus for testing a cellular phone comprising an RF signal generator (122) for transmitting an RF signal (RF10) to said cellular phone, said RF signal generator receiving an input digital signal (DSIG10) which determines the characteristics of the RF signal, means (112, 116) for providing said input digital signal comprising means for receiving a digital signal (DSIG4, DSIG5), and at least one set of digital means, each set (A, B, C) of digital means comprising: a first digital means (200, 201, 202) to provide a first digital signal element relating to a first characteristic of said RF signal, and a second digital means (MA, MB, MC) to provide a second digital signal element relating to a second characteristic of said RF signal, and a means (203) to combine said digital signal elements to provide said input signal to said RF signal generator, said first, second and third characteristics comprise phase, amplitude and delay respectively. Thus the signal processing is carried out in the digital phase which is more easily controlled.

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INTERNATIONAL SEARCH REPORT

Inte Application No
PCT/GB 00/02267

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04B H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KALL J: "THE GSM SYSTEM SIMULATOR" PROCEEDINGS OF THE EUROPEAN CONFERENCE ON ELECTROTECHNICS. (EUROCON),US,NEW YORK, IEEE, vol. CONF. 8, 1988, pages 478-481, XP000010527 page 478, column 1, paragraph 1 -page 479, column 2, paragraph 1 page 480; figures 1-3	1-17
A	US 4 669 091 A (NOSSEN EDWARD J) 26 May 1987 (1987-05-26) abstract column 7, line 16-65 figure 5	15-17

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter Application No

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Publication
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Patent family
member(s)

Publication
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US 4669091

A

26-05-1987

NONE

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
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 in its capacity as elected Office

Date of mailing (day/month/year) 28 March 2001 (28.03.01)	Applicant's or agent's file reference HRW/ANR02A
International application No. PCT/GB00/02267	
International filing date (day/month/year) 12 June 2000 (12.06.00)	Priority date (day/month/year) 14 June 1999 (14.06.99)
Applicant LEE, Michael, John	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
 04 January 2001 (04.01.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35 Form PCT/IB/331 (July 1992)	Authorized officer Olivia TEFY Telephone No.: (41-22) 338.83.38
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GB0002267

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

WOODCRAFT, David, Charles
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ROYAUME-UNI

Date of mailing (day/month/year)

05 July 2001 (05.07.01)

Applicant's or agent's file reference

DCW/SH/B2309

IMPORTANT NOTIFICATION

International application No.

PCT/GB00/02267

International filing date (day/month/year)

12 June 2000 (12.06.00)

1. The following indications appeared on record concerning:

☐

the applicant

☐

the inventor

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the agent

☐

the common representative

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2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

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the residence

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020 7253 1214586

Teleprinter No.

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

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the receiving Office

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the International Searching Authority

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the International Preliminary Examining Authority

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the designated Offices concerned

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the elected Offices concerned

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other:

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34, chemin des Colombettes
1211 Geneva 20, Switzerland

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Authorized officer

Anman QIU

Telephone No.: (41-22) 338.83.38